

Tomo Lithographic Molding

*a Breakthrough Manufacturing Process for
Large Area Micro Mechanical Systems*

Michael Appleby, CEO, Mikro Systems, Inc.



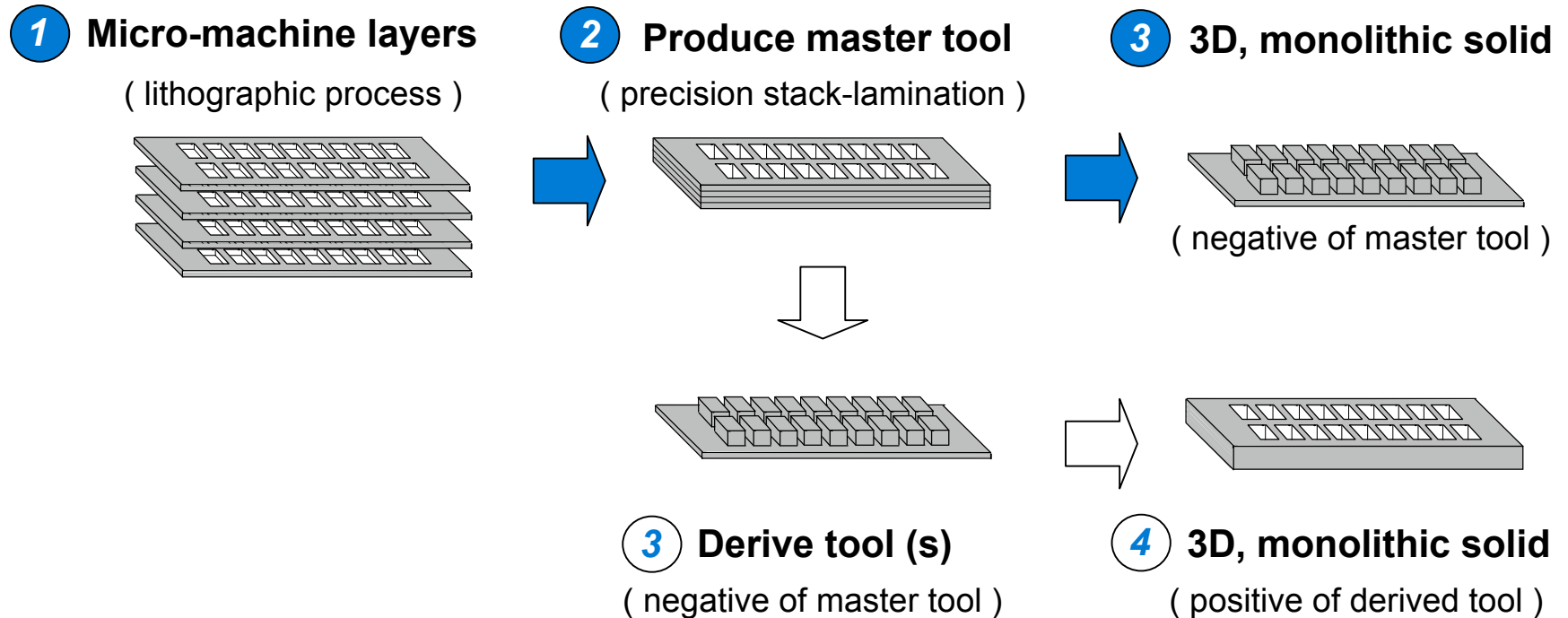
Earth-Sun Technology Conference 2005

- Background
- Process illustration: *Tomo Lithographic Molding™*
- Design variables
- TLM™ process advantages
- MEMS process comparison
- Process application: *Large Area Micro Mechanical Systems™*
- LAMMS™ microstructures
- LAMMS™ product example
- Program-level implications
- Future applications

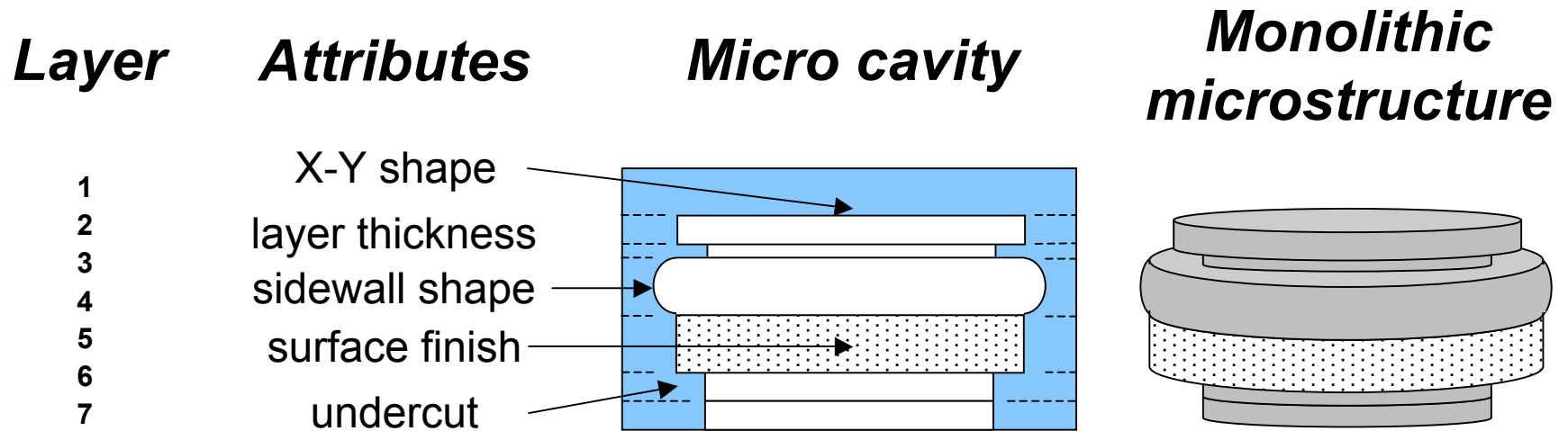
- Rotating modulation collimators
 - RHESSI; Dr. Brian Dennis
- Multi-grid modulation collimators
 - Phase II SBIR (ESA Solar Orbiter); Dr. Brian Dennis
- Sub-millimeter wave feed-horn arrays
 - Sub-millimeter focal plane arrays;
Dr. Harvey Moseley and Dr. Edward Wollack
- Radiation collimators and detectors
 - DOD, DOE, NIH, and commercial customers

Tier 1 supplier of microsystems and devices.

Tomo Lithographic Molding (TLM™)



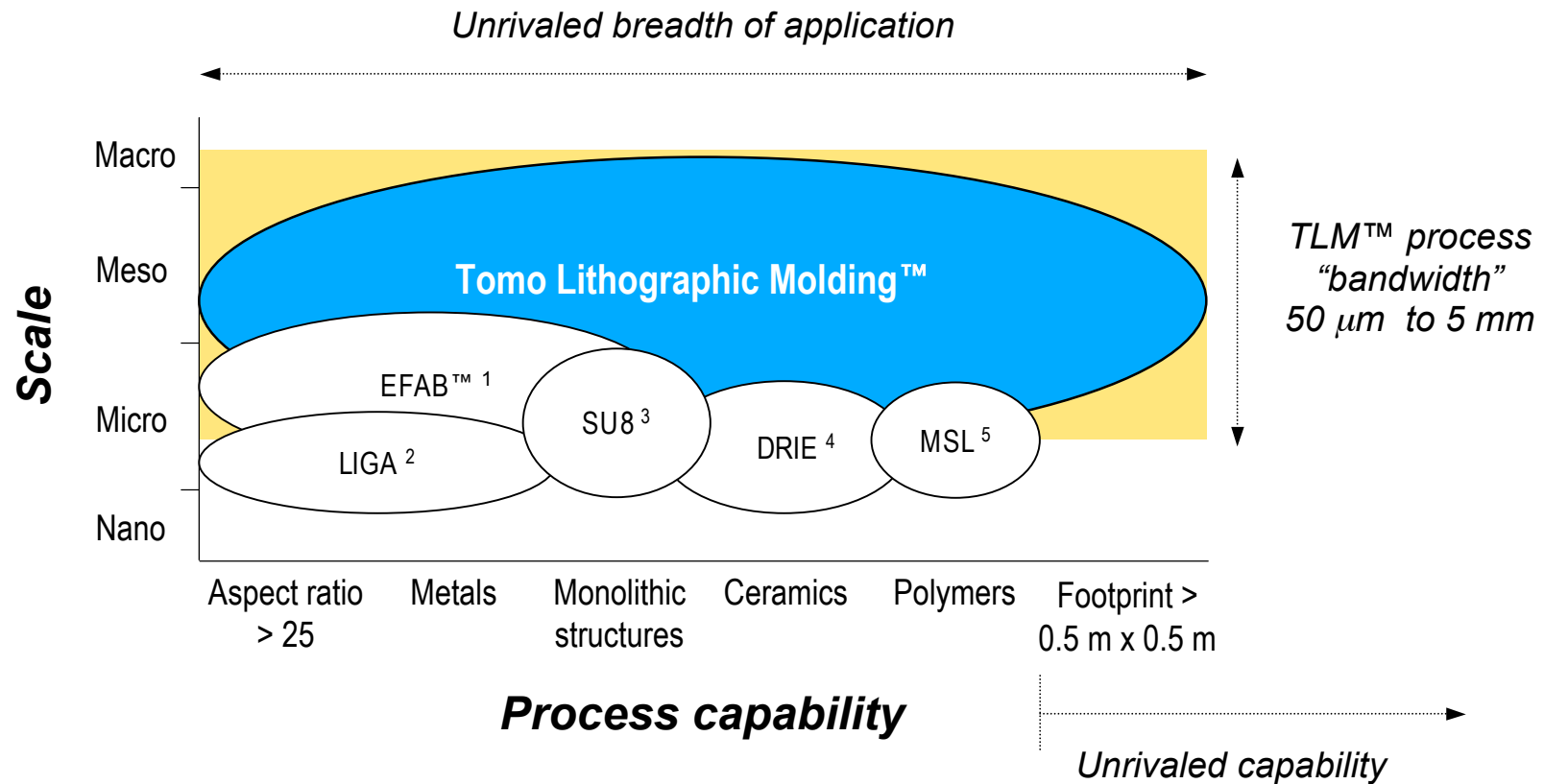
TLM™ is a robust manufacturing process.



Enables 3D design agility.

- Complex 3D fabrication (microns to millimeters)
- High aspect ratio
- Multi-functional materials
- Monolithic structures
 - reduce part count
 - reduce process stages
- Large area capability
- Non-planar and conformal configurations

Cost effective manufacturing process.

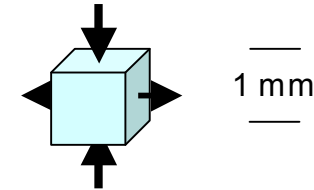


¹ Electro Chemical Fabrication; ² Lithographie Galvanoformung Abformung; ³ SU8 Photoresist; ⁴ Deep Reactive Ion Etching; ⁵ Micro Stereo Lithography

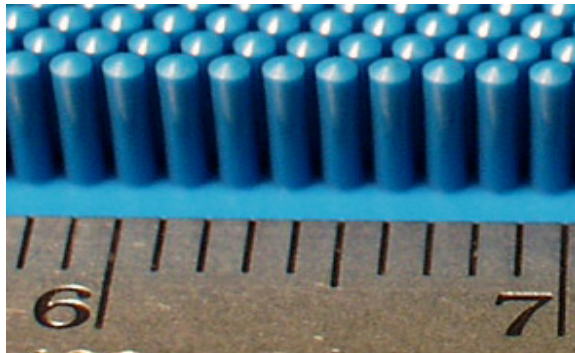
TLM™ is a highly versatile manufacturing process.

Large Area Micro Mechanical Systems (LAMMS™)

- Finite Element Analysis driven
- Custom microstructure per FEA element
- Variable geometry and distribution
- Variable arrays and motifs
- Multi-ply, laminated structures
- Multi-functional materials; synthetic composites
- Suitable for embedded sensors and devices

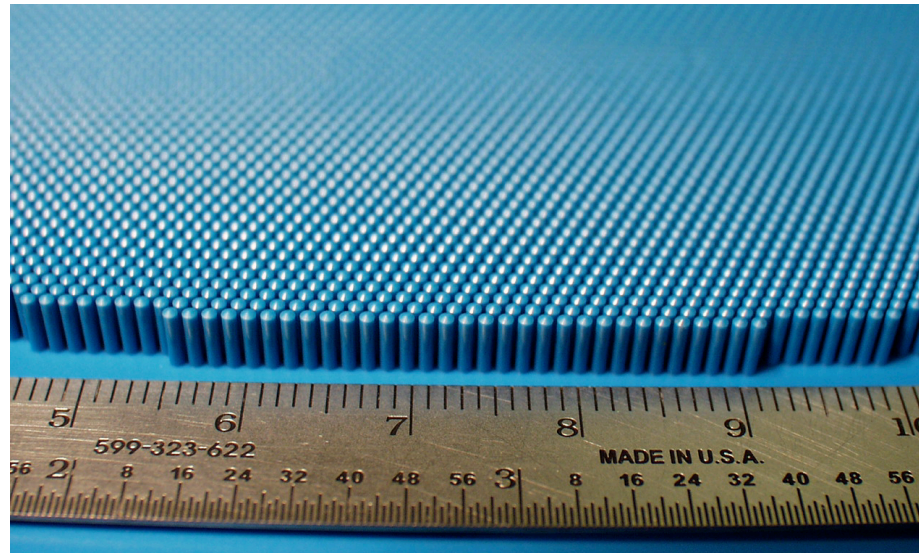


Array custom microstructures over large areas.

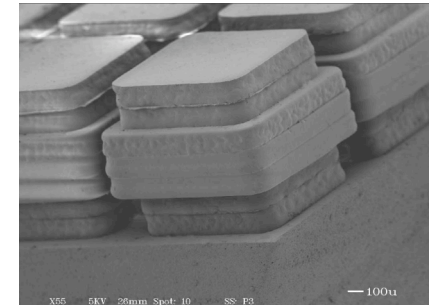
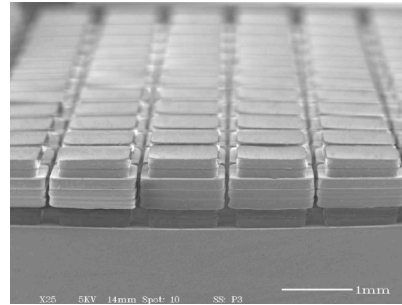
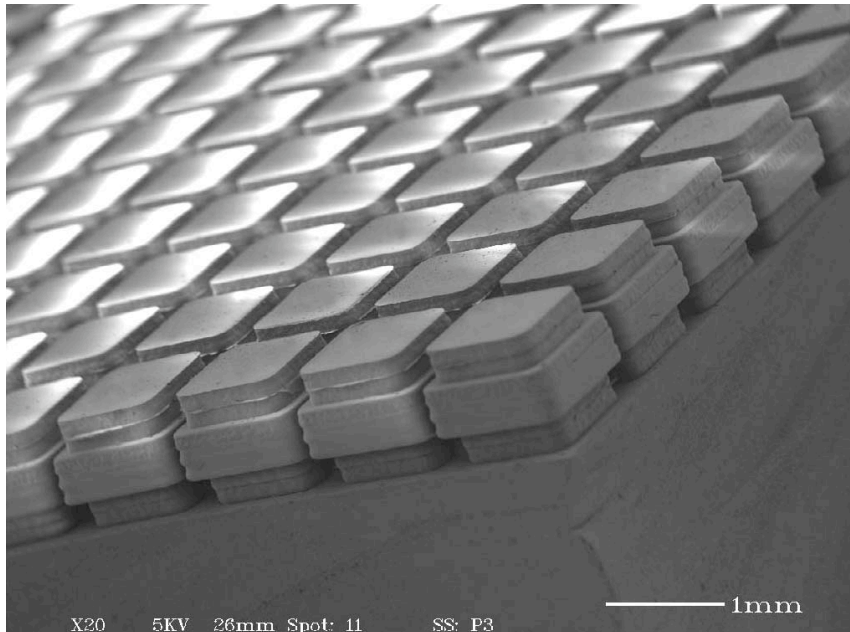


Polymer micro pillar array

- 45 cm diameter footprint
- 131,589 micro pillars
- 0.95 diameter x 3.25 mm pillars
- staggered rows and columns (maximum density)
- pitch frequency 1.0 mm (50 μ m spacing)
- 0° to 2.436° array (increments of 1 arc second / pillar from origin)



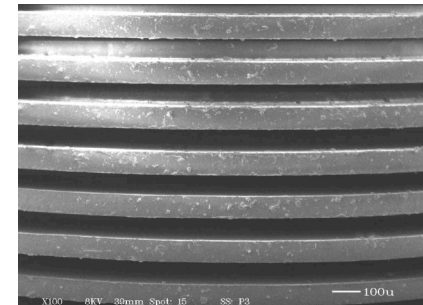
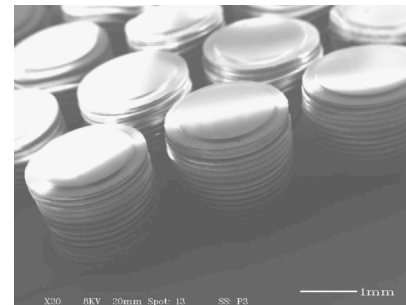
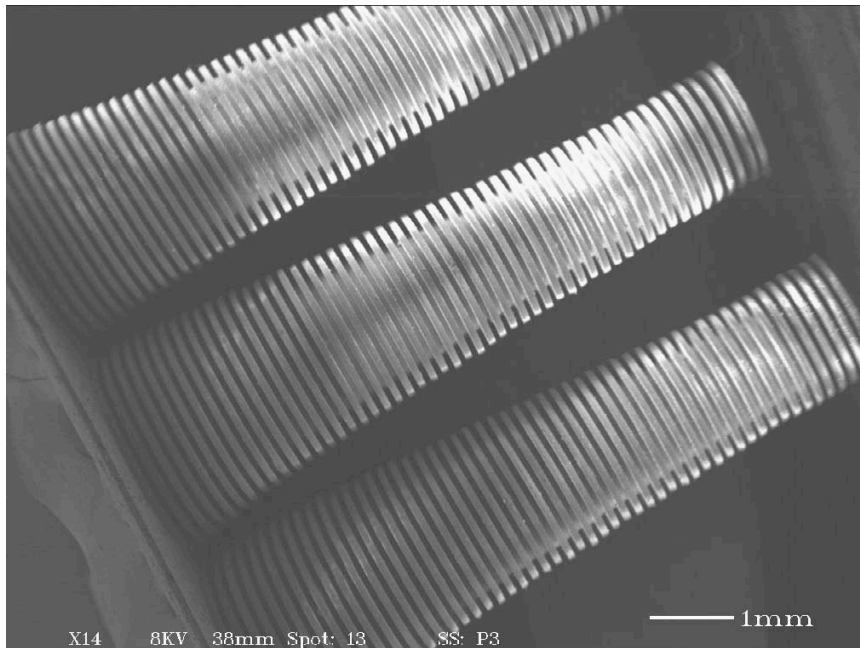
Large area capability.



3D micro pillars

- 1,200 pillars
- top and base sections 870 x 870 µm
- center section 1.035 x 1.035 mm
- ceramic, alumina oxide

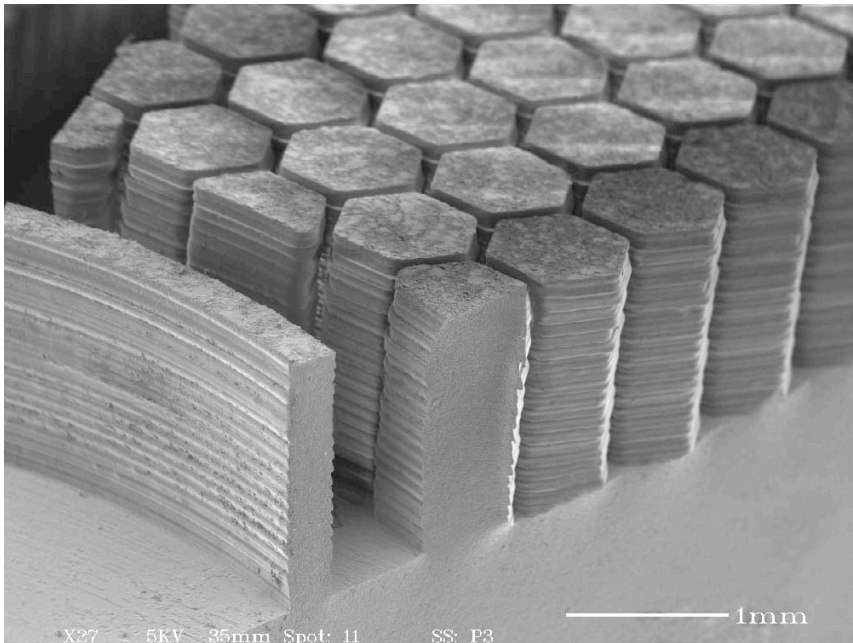
Complex, 3D fabrication capability.



Corrugated microstructure array

- 1,020 microstructures
- 54 circular undercuts on each microstructure (75 μm width x 215 μm depth)
- height = 8.30 mm
- silicone

High surface area.



Hexagonal micro pillar array

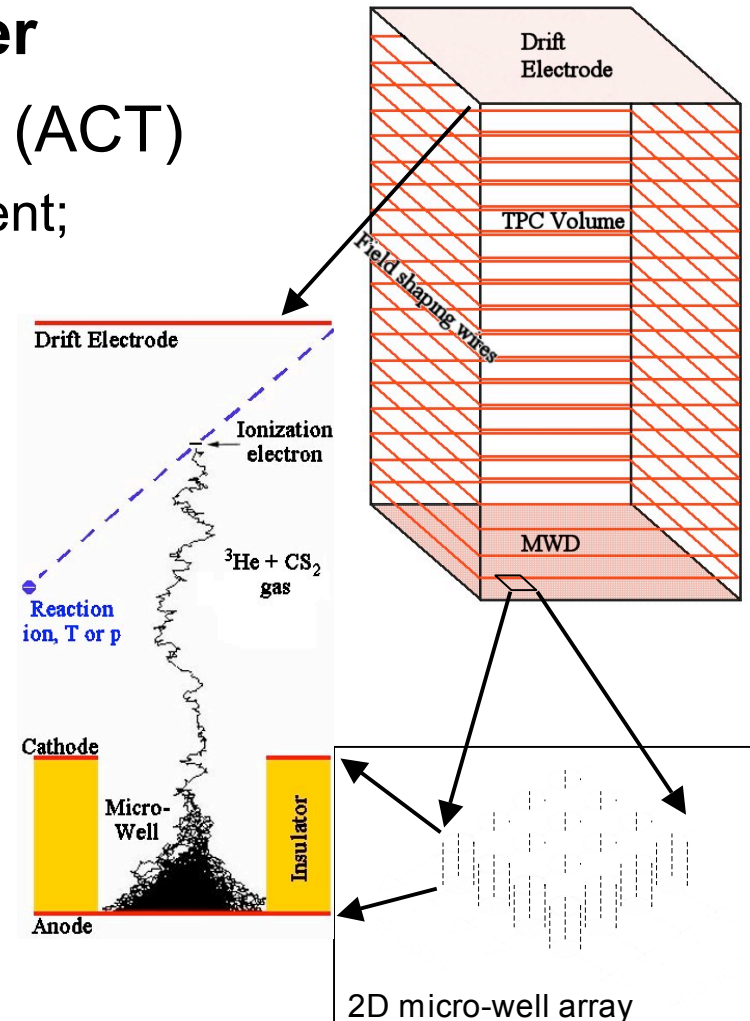
- 1.5 X 0.5 mm
- 0.075 mm spacing
- 13:1 aspect ratio (space)
- PMMA

Monolithic structures.

3D charged particle track imager

- Advanced Compton Telescope (ACT)
 - 2D micro-well detector development;
- Dr. Stan Hunter
- Gamma-ray astronomy and homeland security applications
- Large area detector (m²)
- TLM™ derived, dielectric 2D micro-well array
- Multi-layer construction

Multifunctional structures.



- ***Rapid systems development and prototyping***
 - high fidelity replication of FEA-derived models
 - accelerate development schedules
 - cost effective tooling
 - precisely define design limits
- ***Reliable product realization***
 - scalable process
 - well-defined process control parameters and control limits
 - compatible with conventional shop practices

Reliable; high quality; low recurring costs.

LAMMS™ Aero and astronautics

- Synthetic composite aero structures
- Embedded sensors and devices
- Structural health monitoring
- Thermal management systems
- Aero and fluid dynamics management
- Radiation shielding and detection



Mission Success.